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RELATION BETWEEN GDSS USE AND GROUP TASK COMPLEXITY: AN EXPERIMENTAL STUDY

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RELATION BETWEEN GDSS USE AND GROUP TASK COMPLEXITY: AN EXPERIMENTAL STUDY

Abstract

A laboratory experiment was conducted to explore the influence of GDSS on decision quality, decision time, and user satisfaction under different levels of group-task complexity. Forty-eight groups each consisting of three members were assigned to four experimental treatments that differed in setting (non-GDSS or GDSS) and in group decision task complexity (low complexity or high). Data were obtained on the decision quality, decision time and participant satisfaction. The findings indicate that, compared to working in a non-GDSS setting, the particular GDSS setting used (i) was more effective in solving complex problems, (ii) required more time for a low complexity task but not a high-complexity task, and (iii) resulted in lower satisfaction for a low complexity task but a higher satisfaction for a high complexity task. These findings help identify what type of group problems are better suited for GDSS use.

(GROUP DECISION SUPPORT SYSTEMS; INFORMATION SYSTEMS MANAGEMENT)

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1. INTRODUCTION

Recent advances in computer technology offer a variety of sophisticated tools for providing computer assistance to group decision making. This technology includes hardware for local and wide area networks, distributed processing, electronic mail, decision rooms with projection screens for simultaneous group viewing, windowing, touch screen for voting, and speech recognition. In addition, software specifically designed for group use has become available (Stefik et al., 1987; Nunamaker et al., 1987; Gray, 1987; Hiltz, 1988).

However, the understanding of the complex interaction among the software, the hardware and the group decision making process has lagged the impressive progress in technology because only a relatively small number of experiments have been performed using the technology. For example, Pinnonseault and Kraemer, in their survey report on fewer than 30 experiments through mid-1989 (Pinsonneault and Kraemer, 1989). Despite the early findings that corroborate the positive impacts of GDSS on group-decision outcomes, many practitioners are still not convinced that GDSS is a panacea for all types of group problems. This uncertainty results from generalized but unsubstantiated claims of GDSS benefits and the continuing flux of the GDSS technology as more sophisticated hardware and software become available. The issue, then, is under what circumstances does GDSS make a difference? This paper presents the results of an experimental study designed to help shed light on this issue.

Based on the generally acceptable premise that the developments in GDSS would increase both the efficiency and effectiveness of group problem-solving activities (Huber, 1984), Gallupe (1986) performed initial experiments on the impact of GDSS support for tasks of low and of high difficulty. Among other things, his results indicated that GDSS use (1) enhanced decision quality as task difficulty increased, (2) did not affect decision time for either level of complexity, and (3) reduced user confidence irrespective of task difficulty. An independent experiment by Bui and Sivasankaran (1987) tended to confirm with Gallupe's first finding but not his second or third. Using a more technologically sophisticated environment, Vogel et al (1987) supported our findings of 1987. To help resolve these differences in findings, we conducted a second experiment to determine what problem type -- high complexity or low complexity -- would be better suited for GDSS use. The research design and findings are presented here.

2. RESEARCH DESIGN

2.1 Task Complexity, Group Problem Solving and GDSS

According to Miles (1980), the complexity of a group problem depends on the:

- amount of data,

- clarity of goals,
- clarity in the process of evaluating impacts of solutions,
- level of responsibility in making decisions,
- perceived confidence of consequences of actions,
- risks,
- confidence/satisfaction with the group decisions,
- time pressure,
- analyzability/structure,
- data sharing,
- the conflicting value judgments of group members, and
- the perceived intensity of consequences.

Figure 1 contrasts low and high task complexity problems according to Miles' variables.

We agree with Gallupe (1986) who contends that problems with high complexity lend themselves well to the use of decision aids because the various tools available can assist by providing memory aids, some structure otherwise difficult to visualize, and sensitivity analysis that allows the users to assess the impact of a decision on the various interacting variables. We also agree with Vogel et al. (1987) that in group problem-solving contexts, GDSS can help decompose complex problems efficiently and provide timely sensitivity analysis. Our previous results (Bui et al., 1987) showed that using GDSS for problems of low complexity, although theoretically sound is not worthwhile due to the overhead involved in using the sophisticated tool.

To determine the impact of GDSS on the decision making process, two existing case studies were selected as group decision tasks for experimentation (Pffeifer and Jones, 1972; Mattingly, 1976). One case satisfies the criteria for low complexity and the other for high complexity. These cases were published work and had been successfully used in many empirical studies both to observe problem-solving strategies within work groups and to explore the effects of collaboration and competition in group problem solving.

The Energy International (EI) case (Pffeifer and Jones, 1972) was selected for the low complexity decision task. This management case study deals with the selection of a regional director for an overseas branch of a firm. The case was primarily designed to examine group interaction among a group of five persons, in which each member is given incomplete information on which to base a decision. The case was modified for three-member groups in which each person received the same complete information. This modification kept the level of problem complexity to the low profile as shown in Figure 1.

The Al Kohbari (AK) case (Mattingly, 1976) was selected for the high complexity decision task. The group's task was to recommend a type of armored personnel carrier to be purchased by the Arab nation of AK in the face of an imminent military threat. Unlike the first case in which all information was complete and shared, the amount of data was more substantial and each participant had different and unique information supplied to him/her on his/her data sheets.

<Insert Figure 1 about here>

2.2 Hypotheses

The experimental arrangement, described in more detail later in this paper, is summarized in Figure 2. An equal number of groups were used in each of four conditions, with and without a GDSS and with a low or high complexity task.

<Insert Figure 2 about here>

Four hypotheses were tested using three decision outcome variables (decision quality, decision time, and user satisfaction with the solution) for these two problems. In addition, data were gathered on the user's preference for or against computer support on these problems. Given this 2 x 2 design, we tested the following null hypotheses:

H1: For each level of task complexity, the decision quality is the same for both GDSS and non-GDSS groups.

H2: For each level of task complexity, there is no difference in the time required to reach a decision for both GDSS and non-GDSS groups.

H3: For each level of task complexity, there is no difference between the non-GDSS groups and GDSS groups in their satisfaction with their group decision.

H4: Irrespective of the level of task complexity, there is no difference between the non-GDSS and the GDSS groups in,

H4a: the quality of decision outcome

H4b: the relative time taken to reach a decision

H4c: the group member satisfaction with their group decision.

2.3 Research Settings

Generally speaking, highly complex problems lend themselves well to the use of decision aids because these aids permit efficient decomposition of highly complex decision elements, analysis and resolution to determine the impact of possible outcomes. The GDSS decision aid chosen is called Co-oP (Bui, 1987). Co-oP is described in Appendix A.

Highly complex problems -- with their lack of structure and large number of interacting variables -- are often best solved face-to-face (Toffler, 1980; Rice, 1984). For this reason, the GDSS hardware in the experiment consisted of a decision laboratory equipped with several microcomputer workstations (IBM/XT) connected by a local area network. As shown in Figure 3, the GDSS hardware was arranged so that verbal communication among group members was promoted.

<Insert Figure 3 about here>

To reduce technical difficulties for subjects, a facilitator was provided to each decision group. The facilitator served as a chauffeur, who operated the GDSS hardware and interfaced with the software during the group meetings, and was on call when the group experienced technical difficulties.

2.4 Subjects

Three criteria were considered for the identification, screening and selection of subjects: (1) the backgrounds and skills of participants, (2) the logistics of setting up the experiment, and (3) the number of subjects and/or group size. Nunamaker et al (1987) recommends a group size of eight or more for best results with GDSS use whereas Gallupe (1986) recommends a group size of three for research. Due to the relatively small number of subjects available, we used groups with three members. Furthermore, each group had to work on both cases, one in GDSS mode and one in non-GDSS mode.

Seventy-two subjects were selected from the officer-student population of the US Naval Postgraduate School (NPS). The majority of participants were master students in the fifth quarter (out of six) of the Computer Systems Management; the Command, Control, and Communications or the Telecommunications Systems Management curriculum. All participants had previously taken at least one formal management course at NPS.

The participants were a relatively homogenous group with similar management and educational backgrounds. Most formed their own groups for the experiment and knew each other well. They also had experience with group tasks from previous group project assignments at NPS. This experience is significant because they had developed a relatively cooperative attitude towards working together in teams. Such cooperation reflects a typical organizational decision making environment in which a similar culture and goals are shared. Although the participants' experience at the NPS was similar, their backgrounds prior to attending NPS were diverse. However, one common factor that characterized them all was at least 3-5 years of military management experience.

2.5 Measures

Decision Quality: For our experiments, decision quality was measured using: (1) the number of criteria generated by the group meeting the baseline criteria (baseline criteria are the criteria established by an experts' panel as important elements to be considered), and (2) the correct answer. In calculating the decision quality, we first computed the ratio of the number of criteria identified by the group to the number of baseline criteria identified by the experts. Then, we assigned a score of 1 to the group matching the the correct answer determined by the experts and 0 otherwise. The average the two scores was used as a measure of the decision quality. It was felt that the experimental data would most likely lead to the GDSS groups generating better solutions compared to the non-GDSS, thus resulting in the rejection of H1.

Decision Time: The decision time included read time, discussion, data input, caculation, analyses and final deliberation. It was anticipated that the time required for low complexity problems would be less for non-GDSS groups and vice versa.

Group Satisfaction: Four questions in the form of a participant questionnaire, using a five-point Likert scale, were used to test this hypothesis (Appendix B). These included (1) satisfaction with the final results that the individual/group derived from their inputs, (2) satisfaction with the individual/group solution when compared to the expert's solution, (3) satisfaction with the number of criteria generated, and (4) preference for either non-GDSS or GDSS settings. The overall satisfaction of each group was calculated as the average of the four scores. It was expected that the satisfaction for the GDSS groups would be uniformily high for both types of problems whereas for the non-GDSS groups it would be high for tasks of lesser complexity.

GDSS and Levels of Problem Complexity: To test H4, we pooled the data obtained from the two case studies, irrespective of the difference in their task complexities, according to GDSS versus non-GDSS settings. We then computed the F-statistic for (1) the decision quality, (2) the deicison time, and (3) the group member satisfaction. We anticipated that groups that used GDSS would outperform the non-GDSS groups on all of the above three factors.

2.6 Experimental Procedure

The procedure followed in both the GDSS and non-GDSS groups was very similar. The researchers read a brief set of standard directions that differed among the groups only in that the GDSS groups received some instructions specific to using the GDSS. After the completion of the reading of the case, the groups proceeded with the discussion. The researchers acted as observers in the non-GDSS groups, while in the GDSS groups, one acted as an observer while the other acted as a chauffeur of the GDSS. The observers recorded the criteria generated by the groups, their final decision and anything of interest in the decision process. The observers also recorded the decision time from the handing out of the case until a unanimous decision was reached. Immediately after the groups finished the case, they were shown the correct solution and any questions answered. A questionnaire was then completed by all group members (Appendix B).

3. RESULTS AND DISCUSSION

Decision Quality:

The results of the experiments are summarized in Table 1.

<Insert Table 1 about here>

Baseline Criteria: Baseline criteria refers to the criteria developed by expert panels as being relevant to the case which should be found by the experimental group. These criteria are published in Pffeifer and Jones (1972) and Mattingly (1976). For the EI case, the baseline criteria included: (1) U.S. citizenship, (2) educational qualifications, (3) professional experience, (4) foreign language proficiency, (5) age, and (6) sex. Six of the non-GDSS groups (50%) and seven of the GDSS groups (58%) recognized all the baseline criteria.

We also observed the number of evaluation criteria not identified by the experts but which the group members felt were relevant for the analysis (e.g., field experience, religion, school reputation from where the candidates received their degrees). In principle, a high number of generated criteria would suggest a more creative approach to problem solving (Keen and Scott Morton, 1978). It was found that non-GDSS groups came up with on average three additional criteria than the GDSS groups. This increase was probably the result of the non-GDSS groups having more time to focus on brainstorming. The GDSS groups were driven by the GDSS. However, the slight difference in the numbers of criteria generated had no effect on the final outcome due to the negligible weights assigned to these additional criteria. The details of the weighting scheme are explained in Appendix A.

For the AK case, the task was to appraise the military situation and recommend an Armored Personnel Carrier (APC) out of five APCs. However, the selection criteria were not directly stated in the case as they had been in the EI case. The group members were forced to analyze the problem context and derive evaluation criteria on their own. The experts had identified nine baseline criteria: (1) proven design, (2) fording capability of 5 feet, (3) ability to cross 20-ton bridges, (4) anti-personnel armament, (5) seafaring exporter, (6) at least 7 infantrymen, (7) easy maintenance, (8) uses of U.S. WW II ammo, and (9) diplomatic relations.

When compared to the experts' nine baseline criteria, four out of the twelve non-GDSS groups (33%) identified all of the baseline criteria, as opposed to eight (67%) for the GDSS groups. The mean numbers of baseline criteria identified were 7.17 and 7.75 for non-GDSS and GDSS groups respectively. However, the standard deviation for the GDSS groups (SD=2.05) is larger than the one for the non-GDSS group (SD=1.69).

When all the criteria generated by the group were considered, there were on average eleven for non-GDSS groups and seventeen for GDSS groups -- 55% more than the non-GDSS groups. This difference is attributable to the difference in the nature of the criteria generation processes between the non-GDSS and GDSS settings. In the non-GDSS setting, it was observed that the dominant member(s) of the groups suggested more than 70% of the criteria. In contrast, the criteria generation process with GDSS groups consisted of a series of activities: individual generation of criteria, automated exchange, discussion and consolidation. This process tended to force individual members to input their own criteria (each individual on an average generated six) and the group consolidation contributed to a longer list of group criteria (seventeen). This observation suggests that GDSS not only reduce the influence of dominant members (Van De Ven and Delbecq, 1974) but also promotes individual participation in the group decision process.

<u>Correct Answers</u>: For the EI case, seven of the twelve groups of the non-GDSS groups (58%) correctly matched the experts' choice. For the GDSS groups, eight of the twelve groups did (67%). For the AK case, four of the twelve groups of the non-GDSS groups (33%) correctly matched the master solution. For the GDSS groups, nine of the twelve did (75%).

Average Score for Decision Quality: The scores of baseline criteria and correct solution were combined to derive a score for decision quality using the method discussed in Section 2.5. For the EI case, the analysis of variance resulted in an F-value of 0.05 (Pr=0.80) and the null hypothesis was not rejected. For the AK case, the analysis of variance resulted in an F-value of 5.13 (Pr=0.03) and the null hypothesis was rejected.

However, the comparison of the results between the two experiments must be cautiously interpreted. Since the EI case consisted of choosing the best appointee out of a pool of seven candidates, the verification of the correct answer was univocal. This was not so for the AK case because the best outcome that the non-GDSS group could provide was merely to establish possible alternative solutions and make qualitative recommendations. Meanwhile, the GDSS group with the more formalized evaluation tools at their command went further than the expected qualitative recommendations i.e., they came up with the aggregated ordinal ranking thus rendering the group decision process more structure and the decision outcome more transparency. This goes to strengthen the rejection of H1.

Decision Time:

For the EI case, the average time spent by the GDSS group was 48.50 minutes and 21.25 minutes for the non-GDSS groups, and the standard deviation for non-GDSS groups (SD=6.32) was slightly smaller than the ore for GDSS groups (SD=10.30). Due to the low task complexity several participants felt that they did not need to use the GDSS for assistance. Several of the decision choices were readily dropped from further consideration by the non-GDSS groups, while the GDSS users did not have that option. As a result, non-GDSS groups clearly outperformed. For the EI case, H2 was rejected (F=59.43, Pr=0.0001).

For the AK case, the average time spent was 87 minutes for non-GDSS groups versus 92 minutes for GDSS, and the standard deviation for non-GDSS groups (SD=35.44) was much higher than the one for GDSS groups (SD=20.37). The time distribution for non-GDSS groups is flat with the shortest time as low as 36 minutes and the longest time as high as 166 minutes. This could be explained by the difference in the way the groups handled information exchange and formulating problems and solutions. Since GDSS groups were guided by the tools, members were less tempted to digress and structured their thoughts through group decision techniques built into the system. The difference in time difference was not significant enough to reject the H2 for the AK case (F=0.17, Pr=0.68).

Decision Satisfaction:

Questionnaires returned by the participants were used to measure the satisfaction variable. For the EI case, the mean scores for satisfaction were 3.84 and 4.16 for GDSS and non-GDSS respectively. The F-value was 4.52 (Pr=0.04) resulting in the rejection of H3. The lesser satisfaction among the GDSS groups was the result of the unfamiliarity of the GDSS groups with the software used and their forced reliance on the facilitator to interface with the computer. This probably made them feel less in charge of the task while the non-GDSS groups were entirely on their own and freely used their gut feelings.

For the AK case, the mean scores for satisfaction were 4.08 and 3.87 for GDSS and non-GDSS respectively. The slightly higher level of satisfaction among the GDSS groups is assignable to the fact that the software tools provided decision support to the members in structuring the different alternative solutions in an effective manner, e.g., pairwise comparison, calculation of solution ranking and outranking relations, and aggregation of scores from multiple evaluation criteria. Since, the non-GDSS members did not have the software tools, they were constrained to perform less analysis of the alternatives and hence were less confident in the choice of the final recommendations. But the difference in satisfaction between the two group settings was not significant enough (F=1.86, Pr=0.18) to reject H3 for the problem of high complexity.

GDSS and Levels of Problem Complexity:

The F-statistics using the pooled data for decision quality, decision time and satisfaction were 2.75 (Pr=0.10), 2.46 (Pr=0.12) and 0.14 (Pr=0.70) respectively. Contrary to what we anticipated, all the three hypotheses under H4 were not rejected. When compared to the results obtained for H1 to H3, this suggests that task complexity is an important element to be considered in evaluating the effective use of GDSS.

4. CONCLUSIONS

This paper reports the results of an experimental study that examined the influence of varying levels of task complexity on decision quality, decision time and satisfaction of GDSS use. We had expected that the groups using our GDSS would generate solutions of higher decision quality than those not using GDSS. Our experiment supports this only for the problem of high complexity. It was also observed that using GDSS for a problem of low complexity takes more time. However, there was no significant difference in decision time for the more complex task although there was more variation in non-GDSS groups. With regard to group-member satisfaction, we expected that satisfaction would be high for GDSS groups. The experiment confirmed this expectation, but more significantly for the high complexity task. The most significant implication of this particular study is that GDSS is more beneficial for problems of high complexity.

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APPENDIX A

Overview of Co-Op: A Group Decision Support System

Co-Op is a GDSS for multiple criteria decision making. Installed in a network of MS/DOS personal computer, the software is a color-based, multitask window GDSS which can accommodate several decision members in a face-to-face or distributed group decision making process. Each participant of the group decision making process has his/her own individual DSS whose model base is based on multiple criteria decision methods (MCDM) and other personal decision support tools. The GDSS contains a set of techniques of aggregation of preferences and consensus seeking algorithm that can be used in conjunction with individual MCDM.

An appropriate way to use Co-Op is to follow the basic steps of a multiple criteria problem solving process adapted to a collective decision problem. The Co-Op main menu consists of six steps: (1) problem definition, (2) group norm definition, (3) prioritization of evaluation criteria, (4) individual selection of alternatives, (5) group selection of alternatives, and (6) consensus seeking and negotiation.

First, the group must collectively identify and define a decision problem. Specifically, all group members share the same decision space, i.e., same alternatives and evaluation criteria. The current version of Co-Op supports upto 15 alternatives and 125 evaluation criteria. The criteria can be hierarchically structured.

Second, the group has to identify its members and assign individual passwords. It also has to agree upon the way it handles data transfer, interactive conversation, utilization of electronic mail, and the type(s) of group decision techniques.

The third step deals with the prioritization of evaluation criteria. This process can be either accomplished by requesting the decision makers to assign weights to the criteria directly or by using a routine to help devise a hierarchical prioritization scheme.

Given a defined problem, the fourth Co-Op process allows decision maker to individually evaluate alternatives using his/her preferred or familiar MCDM. For comparison purposes, if Co-Op process act as a single user multiple criteria DSS with data communication support.

The next phase of the Co-Op process is the computation of the group results using the appropriate techniques of aggregation of preferences. The latter use the individual MCDM output to compute group results. Co-Op also allows weighting of users' decisional power.

Finally, if unanimity is not obtained, a consensus seeking algorithm can be evoked in the sixth and last phase. If impasse still prevails, decision makers can attempt to revise their problem representation by going back to any of the previous steps.

The decomposition of the group decision problem into six processes also permit the user to momentarily interrupt his/her analysis at any Co-Op step. Similarly, he/she can look back into the GDSS without having to stop from the first process again. During any phase of the group problem, Co-Op uses an electronic notepad to make it possible for each member to store, move, and process written communication of data among the group members in either formal or informal modes.

Co-Op has been used in teaching and research. The software had been tested by a number of faculty members and graduate students.

APPENDIX B

Satisfaction Questionnaire

Please respond to the following statements by circling the response that best matches your feelings toward the statement. Thank you for your help.

I. CASE

1. Immediately after reading the case study, was the correct candidate intuitively obvious to you?

1	2	3	4	5
Completely Unobvious	Somewhat Unobvious		Somewhat Obvious	Completely Obvious

2. Would you say this case study can be an example of an actual decision making situation in an organization?

1	2	3	4	5
Strongly Disagree	Disagree		Agree	Strongly Agree

3. Does this case study appear to be realistic to you?

1	2	3	4	5
Very Unrealistic	Unrealistic		Realistic	Very Realistic

II. SATISFACTION

4. How satisfied are you with the decision making process that your group underwent to develop solutions?

1	2	3	4	5
Very Unatisfied	Unsatisfied		Satisfied	Very Satisfied

5. How good a solution did your group devise?

1	2	3	4	5
Very Poor	Poor		Good	Very Good

6. How satisfied are you with the number of criteria that you identified?

1	2	3	4	5
Very Unatisfied	Unsatisfied		Satisfied	Very Satisfied

7. How satisfied are you with your group setting?

1	2	3	4	5
Very Unatisfied	Unsatisfied		Satisfied	Very Satisfied

III. OVERALL IMPRESSION

8. What factor, if any, would you say inhibited and/or encouraged your generation of inputs?

9. Was Co-Op user friendly?

10. In what kind of decision making situation would you find Co-Op most useful?

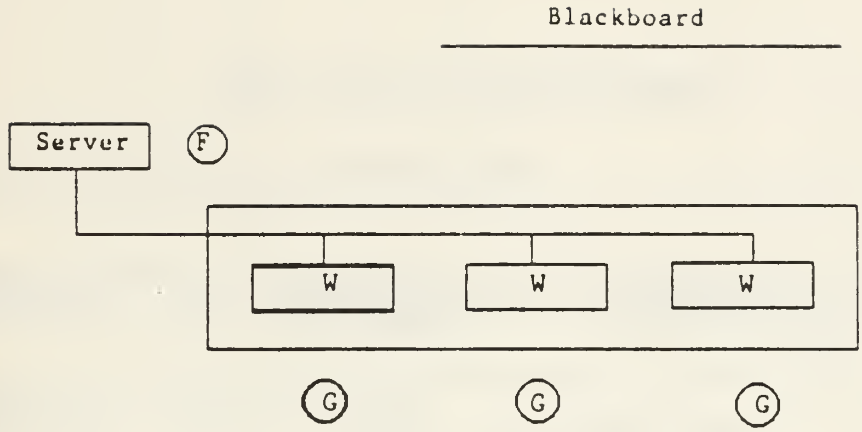
IV. OTHER COMMENTS:

	Level of Problem Complexity		
	High		Low
Amount of data	Large	<---------------->	Small
Clarity of goals	Vague	<---------------->	Clear
Clarity of decision process	Vague	<---------------->	Clear
Level of responsibity	High	<---------------->	Low
Perceived confidence	Low	<---------------->	High
Risk	High	<---------------->	Low
Time pressure	High	<---------------->	Low
Analyzability/structure	Low	<---------------->	High
Data sharing	High	<---------------->	Low
Conflicting value judgments	High	<---------------->	Low

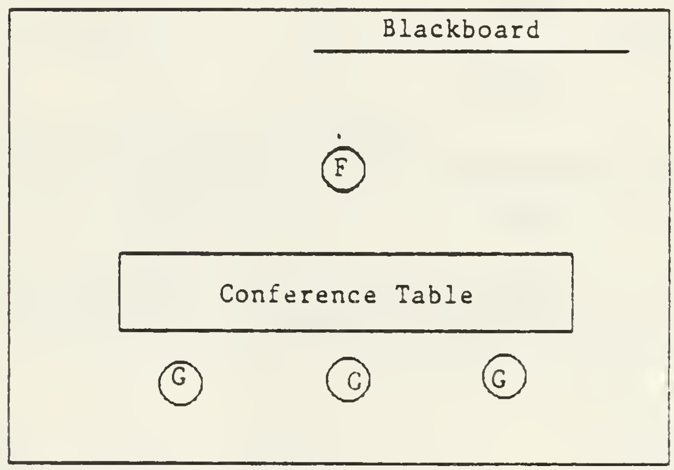
Figure 1. Factors Contributing to Group-Task Complexity

	Task Complexity		
	Low	High	Total
No GDSS	12	12	24
GDSS	12	12	24
Total	24	24	48

Figure 2. Number of Groups Used For High and Low Complexity Tasks With and Without GDSS Support



GDSS SETTING



NON-GDSS SETTING

Legend:

F = Facilitator

W = Workstation

G = Group Member

Figure 3 Laboratory Setting Used in the Experiments

Hypo.	Variable	TaskComplx.	GDSS (Mean/SD)	Non-GDSS	F (Pr)	Conclusion (at 0.05)
H1	Decision Quality	Low	0.78 (0.31)	0.75 (0.28)	0.05 (0.80)	Not Rejected
		High	0.81 (0.21)	0.57 (0.30)	5.13 (0.03)	Rejected
H2	Decision Time	Low	48.5 (10.3)	21.25 (6.32)	59.43 (0.0001)	Rejected
		High	92.25 (20.37)	87.41 (35.44)	0.17 (0.68)	Not Rejected
H3	Satisfaction	Low	3.84 (0.75)	4.16 (0.05)	4.52 (0.04)	Rejected
		High	4.08 (0.53)	3.87 (0.78)	1.86 (0.18)	Not Rejected
	a) Decision Quality		0.79 (0.29)	0.66 (0.30)	2.75 (0.10)	Not Rejected
H4	b) Decision Time	Combined	70.37 (27.36)	54.33 (42.00)	2.46 (0.12)	Not Rejected
	(c) Satisfaction		3.97 (0.64)	4.02 (0.67)	0.14 (0.70)	Not Rejected

Table 1. Summary of Results

List of Recent Working Papers

88-05 Jeffrey E. Kottemann and **Daniel R. Dolk**
"Process-Oriented Constructs for Model Integration," March 1988.

88-06 **Daniel R. Dolk** and Donald J. Kridel
"Toward a Symbiotic Expert System for Econometric Modeling," August 1988.

88-07 **K. J. Euske** and Deborah P. Ward
"Financial Information as an Indicator of Individual Integrity: Finding the Link," August 1988.

88-08 **Shu S. Liao, Thomas P. Moore** and Andrew G. Mackel
"Modeling the Aviation Logistic Support System for a Navy Aircraft Carrier," September 1988.

88-09 **K. J. Euske** and **D. R. Dolk**
"Control Strategies for End-User Computing," September 1988.

88-10 **Rodolfo Alejo Gonzalez** and Roger Nils Folsom
"Rational Adaptation to a Supply Side Oil Shock: An Explanation of Recent U.S. Economic History," September 1988.

88-11 Roger Nils Folsom and **Rodolfo Alejo Gonzalez**
"Trade Deficits, Investment Surpluses, and the Foreign Debt 'Problem'," September 1988.

88-12 **David R. Henderson**
"Are We All Supply-Siders Now?" September 1988.

88-13 **Shu S. Liao**
"Behavior of Three Statistical Sampling Methods: A Comparative Analysis of Their Effectiveness in Defense Contract Auditing," November 1988.

88-14 **Rodolfo A. Gonzalez**, Thomas S. Means, and Stephen L. Mehay "Spillovers and the Demand for Local Police Output," November 1988.

88-15 **Loren M. Solnick**
"Marital Status, Children and Female Quitting," November 1988.

88-16 **Loren M. Solnick**
"Job Quitting: An Application of Event History Analysis," November 1988.

88-17 **Dan C. Boger, Willis R. Greer, Jr.**, and **Shu S. Liao**
"Competition in Defense Acquisition: Myths and Facts," November 1988.

88-18 **Larry R. Jones**
"Program Reduction: The Strategic Uses of Evaluation, Feasibility Assessment and Marketing," December 1988.

88-19 **Moshe Zviran**
"Relationships Between Organizational and IS Objectives: Some Empirical Evidence," December 1988.

88-20 Margaret S. Texidor and **Benjamin J. Roberts**
"Added Perspective, Education, Recognition: Why Nurses Join **and** Stay?" December 1988

89-01 Seev Neumann, Niv Ahituv, and **Moshe Zviran**
"A Model for Determining the Strategic Relevance of IS to the Organization," January 1989.

89-02 Ran Giladi and **Moshe Zviran**
"Centralizing the Data, Distributing the Processing," January 1989.

89-03 **Shu S. Liao**
"Building Spreadsheet Models for Risk Analysis," January 1989.

89-04 Niv Ahituv, Seev Neumann, and **Moshe Zviran**
"Factors Affecting the Policy for Distributing Computing Resources," January 1989.

89-05 David K. Hsiao and **Magdi N. Kamel**
"Heterogeneous Databases: Proliferations, Issues and Solutions," February 1989.

89-06 **William J. Haga, Moshe Zviran** and John D. Hulsey
"Cognitive Passwords: From Theory to Practice," May 1989.

89-07 **Moshe Zviran**
"Design Considerations for Integrated Hospital Information Systems," May 1989.

89-08 **Stephen L. Mehay** and **Loren M. Solnick**
"Defense Spending and State Economic Growth," June 1989.

89-09 **Tung Bui** and Taracad R. Sivasankaran
"Relation Between GDSS Use and Group Task Complexity: An Experimental Study," July 1989.